R-60

RYCOM

INSTRUCTION MANUAL

R-60

SELECTIVE LEVELMETER

RYCOM INSTRUMENTS INC.
9351 East 59th Street.
Raytown, Missouri, 64133

INSTRUCTION MANUAL
R-60
SELECTIVE LEVELMETER

Serial No. _____

Manual Part No. 030 00024 00A

CERTIFICATION

RYCOM Instruments Incorporated certifies that this instrument was thoroughly tested and inspected and found to meet its published specification when it was shipped from the factory.

WARRANTY AND ASSISTANCE

All RYCOM Instruments Inc. products are warranted against defects in material and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed below for the specified period. We will repair or replace products that prove to be defective during the warranty period. No other warranty is expressed or implied. We are not liable for consequential damages.

Exceptions to this warranty are dry batteries or Recharageable batteries which are subject to original manufacturer's inspection and warranty.

This warranty is void if, after having received the instrument in good condition, it is subjected to abuse, unauthorized alteration or unauthorized repair.

Where it is necessary to return the instrument to the factory, furnish information to the nature of trouble encountered. Ship prepaid to:

RYCOM INSTRUMENTS, INC.
9351 East 59th Street
Raytown, Missouri 64133
Attention: Service Department

LIST OF EFFECTIVE PAGES

Total Number of Pages in This Publication is 40.

Page No.	Date	Issue	Page No.	Date	Issue
*Title	3-82		12	7-79	Original
Warranty	7-79	Original	*13	3-82	
*A	3-82		14 thru 15	7-79	Original
B Blank	7-79	Original	16 Blank	7-79	Original
*i thru ii	3-82		*17 thru 19	3-82	
1	7-79	Original	20 thru 21	7-79	Original
*2 thru 3	3-82		22 Blank	7-79	Original
4 thru 6	7-79	Original	23	7-79	Original
*7	3-82		*24 thru 28	3-82	
8 Blank	7-79	Original	29 thru 30	7-79	Original
*9	3-82		*31 thru 33	3-82	
10 Blank	7-79	Original	34 Blank	7-79	Original
*11	3-82				

* An Asterisk indicates pages changed, added, or deleted by the latest revision.

TABLE OF CONTENTS

CHAPTER 1 GENERAL

Page

1.0 Purpose of Manual 1
1.1 Purpose of Equipment 1
1.2 Description 1

CHAPTER 2 OPERATION

2.0 Preparation 3
2.1 Operating Controls and Indicators 3
2.2 Battery 4
2.3 Frequency Range 4
2.4 Calibration 4
2.5 Line Measurements 4

CHAPTER 3 ANOLOG THEORY OF OPERATION

3.0 General 5
3.1 Input Circuitry 5
3.2 Attenuator 5
3.3 Input Amplifier and LPF 5
3.4 Oscillator Injection and Mixing 5
3.5 Filter Driver — Crystal Filter 5
3.6 I-F Amplifier and Metering 5
3.7 Voltage Controlled Oscillator (VCO) 6
3.8 Multi-function Switch A1S1 6
3.9 Power Supply 6
3.10 AC Power Protection 7
3.11 Alarm Assembly A4 7

CHAPTER 4 DISPLAY THEORY

4.0 General 11
4.1 Frequency Display Block Diagram 11
4.2 Reference Oscillator 11
4.3 I-F Subtractor 11
4.4 Negative Frequency Detection 12
4.5 Time Base Divider 13
4.6 Control Signal Generator 13
4.7 Count Gate 13
4.8 Sync 13
4.9 M.S.D. 13
4.10 Cal. 14
4.11 Tracking Generator 14
4.12 Display 14

CHAPTER 5 MAINTENANCE

5.0 Introduction 17
5.1 Test Equipment 17
5.2 Trouble Shooting 17
5.3 Alignment 19
5.4 Power Supply 19
5.5 Reference Oscillator Adjustment 19
5.6 LO Alignment 19
5.7 I-F Alignment 20
5.8 Meter Linearity 20
5.9 Attenuator Tracking 20
5.10 Cal Osc and Signal Threshold Adjustments 20
5.11 Bandpass Response 21
5.12 Frequency Response 21

CHAPTER 6 PARTS LIST

6.0 How to Order Parts 23

LIST OF TABLES

Table No.		Page
1-1	Specifications	2
2-1	Operating Controls and Indicators	3
3-1	A1S1 Continuity Chart	6
5-1	Test Equipment	17
5-2	Power System	17
5-3	Receiver Assembly A1	17
5-4	Timing and Mixer Assembly A2	18
5-5	Display Readout Assembly A3	18
5-6	Alarm Assembly A4	18
5-7	Transistor Voltage Chart	18
5-8	Integrated Circuit Voltages	19

LIST OF ILLUSTRATIONS

Figure No.		Page
1-1	R-60 Selective Levelmeter	1
3-1	R-60 Block Diagram	9
4-1	Subtractor Waveshapes	12
4-2	Subtractor Waveshapes — Negative Frequency	12
4-3	Control Signal Waveshapes	13
4-4	Frequency Display Block Diagram	15
5-1	Test Setup	17
5-2	Test Setup, I-F Alignment	20
5-3	Test Setup, Meter Linearity	20
5-4	Test Setup, Attenuator Tracking	20
5-5	Test Setup, Cal Osc and Signal	21
5-6	Test Setup, Bandpass Response	21
5-7	Test Setup, Frequency Response	21
6-1	Receiver Assembly A1	31
6-2	Timing and Mixer Assembly A2	32
6-3	Display Assembly A3	32
6-4	Alarm Assembly A4	32
6-5	R-60 Alarm Schematic Diagram	33
6-6	R-60 Schematic Diagram	33

CHAPTER 1
GENERAL

1.0 PURPOSE OF MANUAL

1.0.1 This manual contains operation and maintenance instructions for the Model R-60 Selective Levelmeter. The instrument is illustrated in Figure 1-1.

1.1 PURPOSE OF EQUIPMENT

1.1.1 The R-60 Selective Levelmeter is an effective low-cost instrument designed for selective measurements within the audio frequency spectrum.

1.1.2 Typical applications for audio selective meters are:

- Telephone line levels
- Supervisory tone measurements
- Modem frequencies and amplitudes
- Multi-frequency tone separation and measurement
- Program line monitoring
- Power line interference (60 Hz and its harmonics)
- Audio filter response checks

1.2 DESCRIPTION

1.2.1 This instrument is an ideal field unit due to its compact size, ruggedized packaging and internal rechargeable batteries. A major portion of the circuitry is contained on three printed circuit boards. One board processes the analog signal to provide a meter indication. Digital counting functions are performed by the other two boards.

1.2.2 Electrically, the unit is a superheterodyne circuit whose narrow bandpass of 10 Hz is determined by a crystal filter operating at 250 kHz. A 4 ½ digit display provides a frequency resolution of 1 Hz. Mechanical tuning range of 150 turns plus an update rate of 4 Hz prevent a tuning lag when peaking signals. An internal crystal-derived signal of 1000 Hz is utilized as a reference level for instrument calibration.

1.2.3 The unit design incorporates input tranformer coupling for use on balanced or unbalanced lines. Impedances of 600– and 900–ohms, terminated or unterminated, are accommodated.

1.2.4 Electrical and mechanical characteristics of the unit are summarized in Table 1-1.

Figure 1-1. R-60 Selective Levelmeter

Table 1-1. Specifications

CHARACTERISTICS	SPECIFICATION
FREQUENCY:	
Range:	20 to 19,999 Hz
Stability:	Less than ±10 Hz/hour after 1 hour (typical) Less than ±10 Hz/°C at 1 kHz (typical)
Resolution:	1 Hz
Accuracy:	Better than ±3 Hz at 25°C
LEVEL:	
Range:	–60 dBm to +13 dBm (10 dB attenuator steps)
Level Accuracy:	±0.5 dB (50 Hz to 20 kHz, reference 1 kHz) ±1.0 dB (20 Hz to 20 kHz, reference 1 kHz)
SELECTIVITY:	
Filter:	Crystal, 250 kHz
Bandwidth:	10 Hz ±2 Hz at 3 dB points 20 Hz ±5 Hz at 20 dB points 60 Hz maximum at 60 dB points
CALIBRATION OSCILLATOR:	
Frequency:	1000 Hz ±0.02 Hz over operating temperature range
Amplitude:	0 dBm ±0.5 dB ±0.2 dB Initial setting ±0.3 dB over operating temperature range
TRACKING GENERATOR:	
Level:	0 dBm (nominal) open circuit
Output Impedance:	600 ohms balanced
Waveform:	Square, less than 300 ns rise time
SPURIOUS RESPONSES:	
Image Rejection	70 dB minimum below ±10 dBm reference input at 600 ohms
I-F Rejection	70 dB minimum below ±10 reference input at 600 ohms
TEMPERATURE RANGE:	
Operating:	–10°C to +55°C
Storage:	–40°C to +85°C
INPUT CHARACTERISTICS:	
Terminations:	600 ohms, 900 ohms and Bridging
Bridging Impedance:	Greater than 15 k ohms, 100 Hz to 20 kHz Greater than 4 k ohms, 20 Hz to 100 Hz
Configuration:	Balanced, transformer isolated
Maximum DC:	200 V DC, line to line
Common Mode Rejection:	Greater than 65 dB at 60 Hz
(CMR)	Greater than 35 dB at 20 kHz
Connectors:	Binding Posts and WE 310 jack (parallel connections)
POWER:	Two internal rechargeable batteries or 115 volts (230 volts optional) 50-60 Hz for AC operation and battery recharge. Greater than 3 hours continuous use on fully charged battery.
MECHANICAL:	
Dimensions:	5¼" high, 7⅜" wide, 6¾" deep (133 x 194 x 171 mm)
Weight:	7.9 lbs. (3.58 kg)
MISCELLANEOUS FEATURES:	Coarse and Fine tuning 4½ digit, high-intensity yellow display (LED) Signal presence detector (LED) AC power indicator (LED) Over and Under frequency range indication Display update rate of 4 per second Taut band analog meter

CHAPTER 2
OPERATION

2.0 PREPARATION.

2.0.1 The instrument has been thoroughly inspected at the factory and is covered by Warranty. However; before using the instrument, you should inspect it for shipping damage. Report any damage to the carrier and to RYCOM Instruments, Inc.

2.1 OPERATING CONTROLS AND INDICATORS.

2.1.1 Table 2-1 lists and describes the instrument controls and indicators.

Table 2-1. Operating Controls and Indicators

PANEL MARKING	DESCRIPTION	FUNCTION
None	Meter, 100 μA taut band	Used primarily in conjunction with attenuator to obtain DBM levels. Also used to monitor battery voltage.
SIGNAL	High-intensity LED (red)	Illuminated if metered signal strength exceeds -20 dBm.
CAL LEVEL	Potentiometer, 10 k rheostat connected.	Sets unit gain during calibration.
FREQUENCY-Hz	4½ digit LED display, High-intensity yellow.	Provides a frequency indication with 1 Hz resolution.
INPUT	Binding Post connectors. We Co. 310 jack.	Balanced signal input for measurements. We Co. 310 and binding posts are parallel inputs isolated from chassis ground.
	Toggle switch	Selects bridge or terminate modes for the input signal.
FUNCTION	10-position rotary switch.	DBM positions; (-40 thru +10), Unit is operable. Attenuation is controlled in 10 dB steps. CAL 1KHz; Removes external signal and inserts a 1000 Hz (0 dBm fundamental) level in its place. CHARGE; AC indicating LED illuminates when power is applied. Unit circuitry is disabled. All charging current is supplied to the internal batteries. OFF; All circuitry including the battery charger is disabled. BAT. TEST; Spring-loaded return which provides a metered battery indication. SIGNAL and the display readout is also exercised.
AC	High-intensity LED (Green)	Indicates presence of AC line power.
TUNING	Drive reduction mechanism.	Provides both coarse and fine tuning capability.
115 VAC (Rear panel)	Polarized Connector.	Provision for connection to the AC power line.
SQ WAVE TRACKING OUTPUT (Rear panel)	WE Co. 310 jack	Provides a square wave output which tracks the input signal frequency. (0 dBm square wave equivalent).
FUSE (Rear panel)		Provision for fusing AC power line.
AUDIO LEVEL (Rear panel)	Potentiometer	Adjust audio level of aural alarm.

2.2 BATTERY

2.2.1 Battery capability is conservatively rated at 3 hours of operation at 25°C. A completely discharged battery will recharge in 10-12 hours. The instrument cannot be operated when the FUNCTION switch is in the CHARGE position. When the FUNCTION switch is in any of the DBM (–40 thru +10) positions and the AC power is applied, the battery is charged but at a rate slower than the quick charge rate.

2.2.2 If the instrument is operated on AC power more than 70% of the time, there should be no need for quick charging. If the instrument has operated battery powered for 3 hours, 10-12 hours of AC operation or a quick charge should take place before a second 3 hours of battery operation.

NOTE: Excessive use of the quick charge should be avoided as excessive over-charging will shorten battery life.

2.2.3 To quick charge battery, connect instrument to primary source (115 VAC) and set FUNCTION switch to CHARGE.

2.2.4 To test condition of battery while it is delivering full load, set FUNCTION switch to BAT. TEST. The meter indication for an adequately charged battery will vary from unit to unit. This indication will be in the green area. The meter will indicate at 0 dB or below when approximately 95% of the capacity of the battery has been consumed.

2.3 FREQUENCY RANGE.

2.3.1 The specified tuning range of the instrument is between 20 Hz and 19,999 Hz. Degradation of performance will occur beyond these limits.

2.3.2 The user should be aware of the indications beyond the specified limits since they could appear to be an equipment malfunction. Below zero frequency, the indication is 0000. Display counting should resume when TUNING is rotated clockwise past the zero frequency point. Above 19,999 Hz, the FREQUENCY-Hz window will have four blinking decimal points. Frequency in excess of 20 kHz will also be displayed. However; this overflow number is not precise but represents a good approximation of the actual frequency excess.

2.4 CALIBRATION.

2.4.1 The internal calibration signal is a 1000 Hz square wave adjusted to a precise level at the factory. Its frequency accuracy is 0.02 Hz. This frequency accuracy is useful in determining the small error in crystal filter center frequency which may occur.

2.4.2 To calibrate the instrument, perform the following steps:

a. Set INPUT to BRG-600Ω.
b. Set FUNCTION to CAL 1 KHz.
c. Adjust TUNING to obtain a peak indication (1000 ±3Hz).
d. Adjust CAL LEVEL for a 0 DBM meter indication to calibrate for TERM-600Ω, BRG-600Ω, and TERM-900Ω.

Note: To bridge a 900–ohm system, adjust CAL LEVEL in step 2.4.2.d to –1.76 DBM (green indicator line). Unit calibration (900Ω) is valid *only* for the BRG position if green indicator line is used.

2.5 LINE MEASUREMENTS

2.5.1 Normally it will not be necessary to remove the AC line cord from the 115 VAC receptacle when using the instrument. If 60 Hz or its harmonics present a problem, the power cord can be removed and the unit operated in the battery mode.

a. Connect the instrument INPUT jacks to the curcuit to be tested. Do not exceed 200 V DC on the signal input jacks.
b. Calibrate the instrument as outlined in paragraph 2.4.2. Should a 1 kHz signal be present on the input terminals during calibration, a beat effect will be observed which may interfere with unit calibration. If noticed, remove the SIGNAL input during calibration.
c. Set the INPUT impedance selector to the desired position.
d. Set the FUNCTION switch to the appropriate DBM position to prevent insturment overload when seeking a signal.
e. Adjust TUNING for maximum indication on the meter.
f. Read the meter indication in dBm. To obtain the input signal level, algebraically add the meter indication to the attenuator switch setting.

CHAPTER 3
ANALOG THEORY OF OPERATION

3.0 GENERAL.

3.0.1 Up-conversion heterodyning, commonly employed in selective levelmeter designs, are utilized by the instrument. Basically, the instrument employs a single-conversion superheterodyne circuit with a 10 Hz bandwidth crystal filter to measure frequencies within the audio range. Figure 3-1 is a functional block diagram and figure 6-4 is the schematic diagram.

3.0.2 At the input of the instrument, a switch is used to connect the input circuitry to the internal calibration source or the front panel input jacks. A step attenuator provides increments of 10 dB to control the input sensitivity. After the attenuator, a preamplifier drives a lowpass filter which precedes the mixer. The lowpass filter prevents unwanted signals from reaching the mixer input.

3.0.3 Tuning is accomplished by a variable frequency oscillator. The input signal frequency and local oscillator injection signals are heterodyned in a mixer to produce a 250 kHz difference frequency. A narrow band crystal filter selects the 250 kHz component of the mixer output and determines the selectivity of the instrument. After amplification by two I-F gain stages, the signal is rectified, filtered and applied to a sensitive meter which indicates in DBM.

3.1 INPUT CIRCUITRY

3.1.1 Input signals are applied across the E1-E2 terminals of the unit and through A1C1 to the primary of the 1:1 isolation transformer A1T1. A1R1 is the bleeder resistor used to bleed off any high voltage charge stored by blocking capacitor A1C1 when removed from a high voltage circuit. The application of this trapped DC charge to a sensitive circuit could otherwise be disastrous.

3.1.2 Resistors A1R2 and A2R3 are switched into the circuit by S1 to terminate the 600- and 900-ohm lines.

3.2 ATTENUATOR.

3.2.1 With the "C" section of A1S1 as shown on the schematic, A1T1 output is fed to a string of resistors which consists of A1R4 thru A1R10. This resistor network forms a voltage divider or stepped attenuator for the input signal. A1S1d selects the desired attenuation level. Output from the attenuator is taken from A1S1d position 8.

3.2.2 In the CAL 1KHz position, A1S1-C positions 11 and 2 are open, disconnecting the transformer input signal. Positions 2 and 5 are made. The 1000 Hz signal from the A2 board is substituted for the input signal for calibration.

3.3 INPUT AMPLIFER AND LPF.

3.3.1 A1I1 is a low noise J-FET input op-amp connected in a conventional inverting configuration. In the operating frequency range of the instrument, A1C4 has negligible effect on the frequency response so the input impedance is effectively A1R15 in series with A1R14. However, the A1R15-A1C4 combination does provide addtional attenuation for the I-F frequency of 250 kHz. In the operating frequency range, the voltage gain of A1I1 is close to 0.4.

3.3.2 Wide separation of the passband and I-F frequencies allow the lowpass filter (LPF) to be a simple design. The LPF has equal input and output impedances and a passband extending to 22 kHz.

3.4 OSCILLATOR INJECTION AND MIXING

3.4.1 Mixing is accomplished by switching the input signal at the desired carrier frequency rate. Since the VCO runs at a frequency rate of (4X) the required carrier signal frequency, A1I2a and A1I2b divide the VCO frequency by 4. This divide by four provides a symmetrical waveform for mixer switching. The frequency for mixer switching is equal to 250 kHz + f_{in}.

3.4.2 Mixing is accomplished by two of the four available sections of A1I3. A1I3 is a quad bilateral switch. In MOS technology, these bilateral switching elements are commonly known as transmission gates. The control pins for switch control are pins 5 and 6. When the control voltage is high, the associated input-output pins act as a closed switch. For a logic low, the gate becomes a high impedance or open.

3.4.3 Thus when I2b Q is high, the I-F input to A1Q1 is grounded. When $\overline{Q}$ goes high, the LPF signal is passed to A1Q1. This audio signal is chopped during each half-cycle of the injection frequency. At A1Q1, the result is a mixed frequency signal input containing the desired difference frequency signal.

3.5 FILTER DRIVER-CRYSTAL FILTER

3.5.1 A1Q1 amplifies the mixed output before applying it to the crystal filter. Voltage feedback via A1R18 and current feedback by A1R20 stabilize the operating parameters of the transistor.

3.5.2 A1FL1 requires equal input and output terminations of 2000 ohms. The collector load of A1Q1 terminates the filter input. A1FL1 output termination is essentially A1R22, A1R23 and A1R24 in parallel. With these terminations, A1FL1 exhibits a flat-top response with a 3 dB bandwidth of 10 Hz.

3.6 I-F AMPLIFIER AND METERING

3.6.1 Three cascaded transistor amplifiers (A1Q3, A1Q4 and A1Q5) are the active gain blocks of the I-F amplifier. These blocks are of standard design.

3.6.2 A1Q3 is an emitter follower which supplies low impedance base drive to A1Q4. The emitter current and gain of A1Q4 are controlled by the CAL LEVEL variable resistor R2. Since R2 completes the emitter circuit to ground, the emitter resistance of A1Q4 is variable from 1 k to 11 k ohms for instrument calibration.

3.6.3 The final I-F amplifier A1Q5 has two gain values controlled by the INPUT switch S1. Normally, A1E6 from S1 is open. Transistor A1Q2 is saturated due to base drive through A1R21. With A1Q2 saturated, an effective ground is placed at the junction of A1R28 and A1R29. In the TERM-900Ω position, A1Q2 is turned off and the emitter resistance of A1Q5 increases to the series value of A1R28 and A1R29.

3.6.4 Output from A1Q5 is fed to a voltage doubling amplitude detector consisting of A1C19, diodes A1CR3-A1CR4, and RC filtering components. The filtered output is applied to the DBM meter M1. The meter level serves as the driving source for the SIGNAL comparator on the A2 assembly.

3.7 VOLTAGE-CONTROLLED OSCILLATOR (VCO)

3.7.1 The VCO A1Q6 is a common-base Clapp circuit operating at four times the mixer injection frequency. Varying the DC tuning voltage for hyper-abrupt varactor A1CR5, provides the linear frequency control characteristic of the instrument.

3.7.2 The output of A1Q6 is buffered by A1Q7 for use by the divide by 4 circuit. To prevent digital interaction, additional isolation of the VCO is supplied by emitter-follower A1Q8.

3.8 MULTI-FUNCTION SWITCH A1S1

3.8.1 FUNCTION selector switch A1S1 performs a multitude of switching. Seven wafers and ten switching positions are involved. To aid in visualizing circuit functions, Table 3-1 shows switch continuity of the various wafer contacts.

3.9.2 The power transformer T1, bridge rectifier CR1 and rechargeable batteries BT1 and BT2 are physically located on the main chassis of the instrument. Power supply switching by A1S1, control circuitry and three-terminal regulator A1I7 reside on the A1 circuit card assembly.

3.9.3 CR1 supplies full-wave rectified DC across terminals A1E15 and A1E16 whenever the AC power line is energized. The high side (+) of the rectifier is switched on through A1S1B rear contacts 8 and 9. In all other positions, the rectifier output is filtered by A1C34 and applied to A1I7 and to the AC indicating LED A1CR10. Notice that the rectifier current must flow from the (–) terminal through A1R55 to complete the circuit. A1R55 indirectly monitors battery current drain by sensing current drawn from the rectifier. Current limiting of A1R55 is covered in a later paragraph.

3.9.4 A1I7 is a programmable three-terminal regulator whose output voltage is dependent on the voltage applied to its center or adjustment pin. In normal operation, the output of the regulator is solely a function of a resistance divider network consisting of A1R49, A1R50, A1R51, A1R53 and A1R54 which determines the voltage level on the regulator center pin.

Table 3-1. A1S1 Continuity Chart.

Switch Pinout (Viewed from top)

9 8 7 6 5 4 3 2 1 12 11 10

Knob End

PANEL MARKING	SECTIONS							
	A		B		C		D	
	Front	Rear	Front	Rear	Front	Rear	Front	Rear
-40	6-9	—	12-11-2	8-9	8-9-10	11-2	10-6-7	11-8
-30	6-9	—	12-11-2	8-9	8-9-10	11-2	6-7	12-8
-20	6-9	—	12-11-2-4	8-9	8-9-10	11-2	6-7	1-8
-10	6-9	—	12-11-4	8-9	8-9-10	11-2	6-7-10	2-8
0	6-9	—	12-11-4-6	8-9	8-9-10	11-2	6-7-10	3-8
+10	6-9	—	12-11-6	8-9	8-9-10	11-2	6-7-10	4-8
CAL 1KHz	6-9	—	12-11-6	8-9	8-9-10	2-6	6-7-10	5-8
CHARGE	6-9	—	12-11	8-9	—	2-6	6-7-10	
OFF	6-9	—	12-10	—	—	2-6	6-7-10	—
BAT. TEST	6-9	—	11-10	—	—	2-6	7-10	—

3.9 POWER SUPPLY OPERATION

3.9.1 The primary purpose of the power supply circuitry is to provide the proper battery charging voltage for the instrument in the charge and the operate conditions. This battery charging voltage is distributed to on-board regulators which minimize interaction and provide stable DC operating potentials for the instrument.

3.9.5 Current limiting is provided by A1Q9. Two current limiting values are used. The current limit value in the CHARGE mode must keep the initial battery current below 400 mA specified by the battery manufacturer. The emitterbase junction of A1Q9 and the diode gap voltage of A1CR11 determines the current limit point which is reached when A1Q9 begins to turn on. Assuming a turn-on voltage of 1.1 volt (diode plus transistor emitter-base), the voltage developed across A1R55 provides a current limit of 380

mA. In normal operation (i.e. when unit is not off or charging), A1S1C (front) parallels A1R55 with A1R56. This raises the current limit level high enough to allow for the additional drain of the instruments circuitry.

3.9.6 Op-amp A1I6 has a function only in the CHARGE mode. The ground applied to A1CR6 cathode overrides the op-amp. A1CR9's cathode is released only in the CHARGE mode. In the CHARGE mode with higher currents, the op-amp A1I6 is high and A1CR8 is back-biased. When the charging current through A1R48 drops sufficiently, A1I6 trips and its output goes low. This reduces the charger output to the "float" voltage level. In effect, the op-amp provides a two-stage charging supply for the batteries.

3.9.7 In BAT. TEST, the charging supply is disconnected from the battery. The battery is connected directly to the instrument circuitry so it can be monitored under a loaded condition.

3.10 AC POWER PROTECTION

3.10.1 A fuse is connected in the AC power line, located on the Rear panel and is easily accessible.

3.11 ALARM ASSEMBLY A4

3.11.1 LS1 is a ceramic transducer that provides an aural alarm, indicating signal presence. A4I1b is an audio oscillator whose frequency is determined primarily by A4R5 and A4C1.

3.11.2 Comparator A4I1a output controls the on-off operation of the oscillator by switching the DC reference voltage of A4I1b-3. When the detector voltage at A4E2 approaches the threshold set by voltage divider A4R1-A4R2, pin 7 of A4I1a rises, allowing pin 3 to rise. This voltage energizes the audio oscillator.

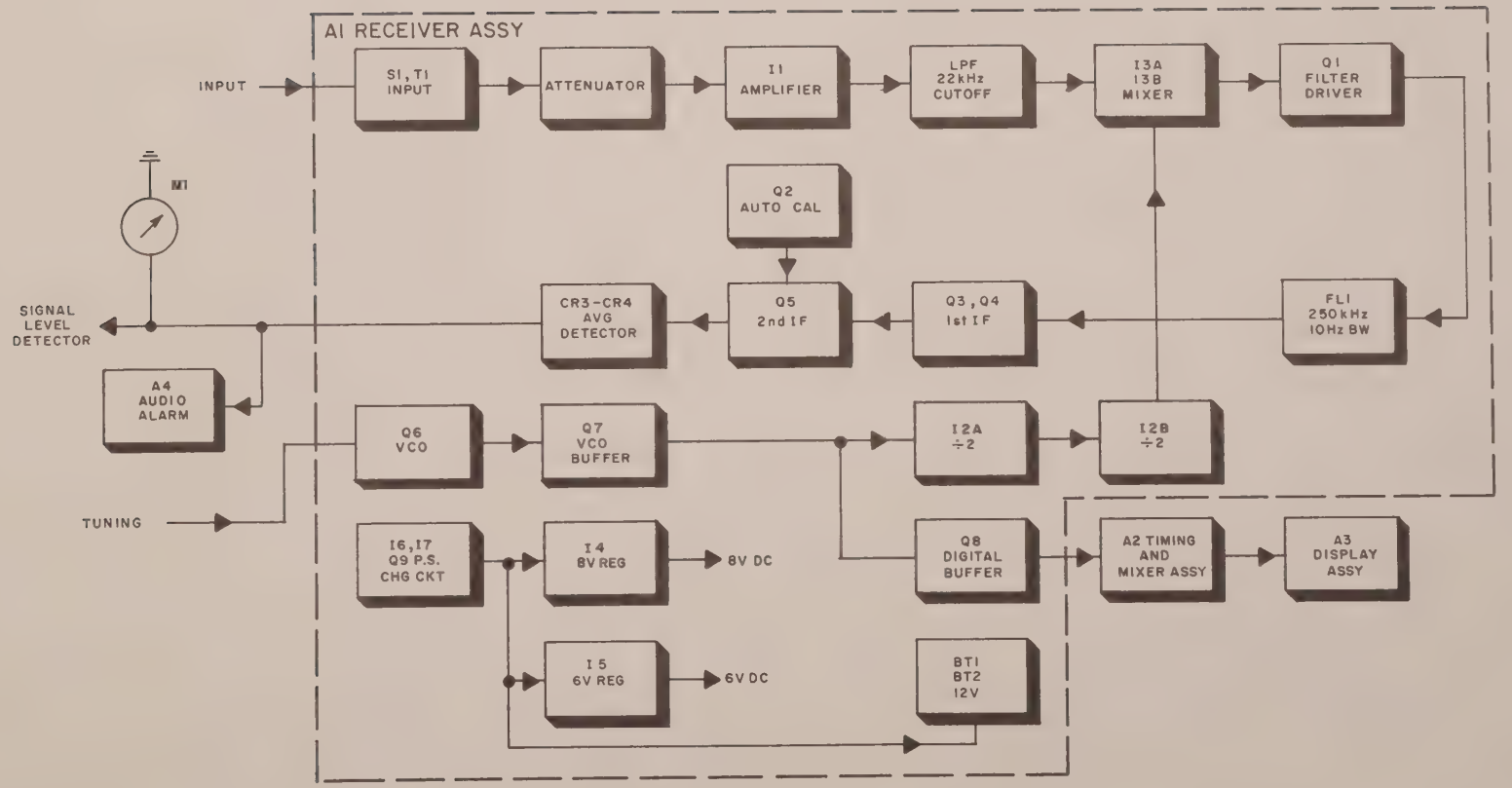

Figure 3-1. R-60 Block Diagram

CHAPTER 4
DISPLAY THEORY OF OPERATION

4.0 GENERAL

4.0.1 Two digital boards (A2 and A3) monitor the LO frequency and generate the FREQUENCY-Hz count display. A2 is the Timing and Mixer assembly, A3 is the Display Readout assembly. Figure 4-4 shows a block diagram of the frequency display system and the schematic diagram is located on figure 6-4. After a brief description of the system operation, a more detailed explanation of the operation of individual blocks will be given.

4.1 FREQUENCY DISPLAY BLOCK DIAGRAM

4.1.1 The Reference Oscillator block generates a 1.0 MHz reference signal used to generate an accurate count interval and is also used as a BFO type signal for subtracting the I-F frequency from the LO frequency.

4.1.2 Since this meter uses an up-converting heterodyning scheme, the center frequency of the instrument passband will be the LO frequency minus the I-F frequency. The I-F subtractor block has two inputs. One input is from the LO having a frequency 4 times the LO injection frequency. The second input is from the Reference Oscillator block and has a frequency of 1.0 MHz or 4 times the I-F frequency (250 kHz). The frequency of the subtractor output to the count gate will be the LO frequency minus 1.0 MHz or 4 times the selected frequency. The output of the subtractor is counted for 0.25 seconds to provide 1.0 Hz frequency resolution.

4.1.3 The Time Base Divider block, is a 256,000 count divider. During the first 6000 counts of a divider cycle, the control signal Generator block is active and generates a count latching signal followed by a master reset signal. These signals go to the Display block and Most Significant Digit (M.S.D.) block where the previous count is latched and the counters are reset for the next count interval. The control signal to the Count Gate block prevents any count inputs to the display counter during this 6000 count conditioning interval.

4.1.4 At the end of the conditioning interval, the Control Signal Generator provides a hold signal to the Time Base Divider. This signal delays the start of another count interval until the hold signal is removed by action of the Sync block. The Sync block is clocked by the leading edge of the count signal held, a releasing signal is provided by the Sync block and a new count interval is enabled. This means that the count interval, during which the Count Gate passes the subtractor output to the Display block, will start with the leading edge of the count signal. The count signal has an average duty cycle of 50% and the Display counter is advanced on the center transition of a count signal cycle. These facts provide for a count accuracy which approaches ±0.5 of the least significant digit.

4.1.5 The count interval has a duration of 250,000 divider inputs, which for a 1.0 MHz input provides a 0.25 second interval.

4.1.6 The Display block contains a four-digit decade counter, latch and multiplexing integrated circuit, along with five L.E.D. seven-segment displays and the required discrete components.

4.1.7 The Most Significant Digit (M.S.D.) block counts the carry outputs from the display four-digit counter. If a single count is recorded during a count interval, a signal is provided to the Display for the illuminating of a 1 on the 10,000 digit. If two carry outputs are received during a count interval, an overflow situation exists. In this case, a signal is provided to the Display for lighting the decimal points of four digits. Another signal to the Time Base Divider inhibits dividing until a fourth carry input occurs. This action provides a blinking decimal point display when the instrument is tuned above the 19,999 Hz frequency limit.

4.1.8 The Cal and Tracking Generator blocks provide useful signals extracted from A2 circuitry. The Cal block takes a 1.0 kHz signal from the Time Base Divider and attenuates the signal to provide a -30 dBm (600-ohms), 1.0 kHz input to the instrument. The $\overline{\text{CAL}}$ signal enables the output of the Cal block and disables the sync delay during calibration. Disabling the sync delay prevents an interruption of the 1.0 kHz signal which would occur during normal operation.

4.1.9 The I-F Subtractor (or Mixer) generates a signal which has a frequency two times the selected input frequency. By dividing the two times signal by two and the provision of buffering, a signal having a 0 dBm (600-ohms) fundamental component at the selected frequency is generated. This division and buffering is accomplished by the Tracking Generator Block.

4.2 REFERENCE OSCILLATOR

4.2.1 The Reference Oscillator consists of transistor circuits Q1 and Q2. Q1 and its associated components form a modified Colpitts type oscillator. Q2 acts as a buffer between the oscillator and logic providing the amplification required to provide the 1.0 MHz signal at logic levels.

4.3 I-F SUBTRACTOR

4.3.1 The subtractor consists of the following A2 circuits: I5a, I8a and b, I9a, b and c, I10a and b. The subtractor works on a phase detection principle. The varying phase relationship between two signals of differing frequencies repeat a given phase relationship at the difference (or beat) frequency. Figures 4-2a thru 4-3B show the various wave shapes generated in the subtractor as the phase relationship between the input signals change. The subtractor could be described as a phase detector with phase hysteresis.

4.3.2 The output of the subtractor is taken from the Q output of flip-flop A2I10b. The subtractor output depends on the state of Data input (pin 9) when sampled by the rise of clock input (pin 11). The Data input is derived from the LO signal and the clock input is derived from the Reference Oscillator. Under normal conditions, the LO signal will have the higher frequency. For the waveshapes shown in figures 4-1a thru 4-1d, the clock input signals will shift to the right with respect to the data input signals. In the figures, signals shown below the I10b Q signal are associated with the clock input to A2I10b while those above show how the data input to A2I10b is generated. With each change of state of I10b, the data input or both input waveshapes are modified. The modification insures that the I10b output will remain in the new state until a succeeding phase shift of 90° has elapsed. A phase shift of 90° between I10b inputs corresponds to a 180° phase shift between the two subtractor inputs. Since the subtractor output changes state for each 180° of phase shift between input signals, the output frequency is the difference frequency.

4.3.3 In figure 4-1a, the input to I8b CL (pin 11) lags the input to I10a CL (pin 3) by 90°. Flip-flop I8a has been arbitrarily placed in a set state (Q output hi). For this case, where the I10a input has the higher frequency, flip-flop I10b will be set for the particular input phase relationship. With I10b set the output of I9b is held lo and I9c has approximately a 25% lo time. At time A, the I10b clock samples a hi data input and will continue to sample a hi data input for another 45° of phase shift.

4.3.4 In figure 4-1b, the inputs traverse through the 180° out of phase signal condition. At time B′ the clock input to I10b samples a lo rather than a hi, resetting I10b. When reset, the Q output of the flip-flop goes lo. With I10b reset, the output of I9b becomes active and the output of I9c (I10b data input) changes to a 50% duty cycle. At time B with the now modified data input, the clock input to I10b is sampling lo and will continue to sample a lo until 90° of phase shift has occurred between the clock and data inputs. This action implements the phase hysteresis for this output change.

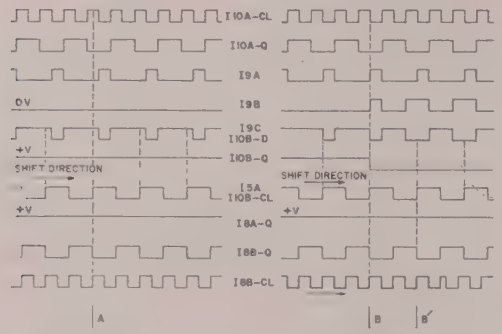

FIGURE 4-1a FIGURE 4-1b

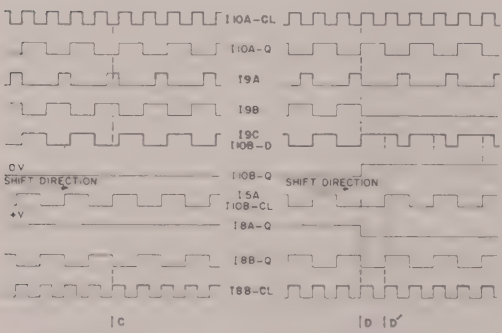

FIGURE 4-1c FIGURE 4-1d

SUBTRACTOR WAVESHAPES

4.3.5 In figure 4-1c, the phase relationship between the inputs is such that the I8b CL input lags the I10a CL input by 270°. With this phase relationship, I10b will still remain reset from the action which took place at time B′. The only difference between the B and the time C waveshapes is the shift in phase of the lower waveshapes.

4.3.6 In figure 4-1d, the input signals pass through an in-phase relationship. At time D, the clock input to I10b samples a hi rather than a lo, thus setting I10b. With I10b set, the I9b output is held lo and the I9c output returns to a negative pulse waveshape. The setting of I10b also clocks I8a. A change in state of I8a results in a 180° phase shift of the I5a output (I10b clock input). At time D′, the waveshape changes have again implemented the phase hysteresis characteristic of the phase detector.

4.3.7 Since flip-flop I8a changes state only when I10b is set, the I8a frequency will be one-half the difference frequency.

4.4 NEGATIVE FREQUENCY DETECTION

4.4.1 It is possible to tune the unit through the below zero frequency. To avoid confusion, the frequency display will go to and remain at a 0000 display when tuned below zero. For frequencies below zero, the I10b clock input will shift to the left rather than to the right. This results from a I-F frequency higher than the LO frequency. Figures 4-2a and 4-2b illustrate waveshapes for the negative frequency condition.

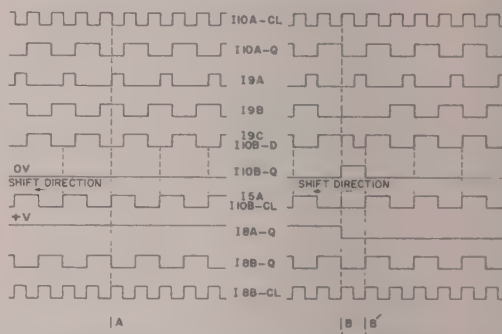

FIGURE 4-2a FIGURE 4-2b

SUBTRACTOR WAVESHAPES — NEGATIVE FREQUENCY

4.4.2 Figure 4-2a has identical waveshapes to those following the time B′ for figure 4-1b. The only significant figure difference is the direction of the phase shift. In figure 4-2b, the clock input to I10b has shifted to a phase relationship to sample a hi out of I9c and I10b is set. The setting of I10b in turn clocks and changes the state of I8a. Acting through I5a, the setting of I10b also causes a 180° phase shift in the clock input to I10b. Unlike the normal (positive frequency) case, this 180° phase shift does not ensure additional hi samples. Instead, the shifting of the clock signal to the left means that a lo sample may be expected on the next clocking or for some small amount of shift to follow. Once the phase relationships have shifted from the time B to the time B′ state, an additional shift of 180° to the left is required before I10b can again be set. The net result is a predominantly lo output from I10b Q.

4.4.3 In the case of a positive frequency and a square wave output from I10b, the voltage on capacitor A2C9 will remain below the input threshold of exclusive OR gate A2I5d. With a lo input from C9 to I5d, count reset outputs from the gate only occur between count intervals following the latching of valid counts. For negative frequencies, the I10b output changes from a square wave to a predominantly reset condition. With I10b reset for an extended time, or for a large fraction of the total time, capacitor C9 charges above the hi threshold of I5d. This means that a count reset output from the gate will hold the count and display in a 0000 state.

4.5 TIME BASE DIVIDER

4.5.1 The Time Base Divider consists of A2I1a, A2I1b, A2I2a and A2I3. I1a, I1b and I2a are three BCD counters connected in cascade to perform a divide by 1,000 function. I3 is a binary counter and the Q9 output from I3-12 changes state for each 256 count inputs. The Q4 (8 count) output from I2a-14 has a 1000 count cycle time. The rise of the I2a-14 output is used by the Control Signal Generator as a clock for detecting changes in the state of I3-12, and for generating the needed control signals. The fall of the I2a-14 output advances the I3 counter. The fact that the Control Signal Generator uses the I2a-14 rise to sample the I3 output means that delays through the I3 ripple counter will not affect the count interval accuracy.

4.5.2 For each 256 count cycle of I3, the first 6 count inputs will be associated with active states of the Control Signal Generator. Following the sixth count (on count 7), a hi reset input to I1a-15 from I4-6 inhibits further divider counting. When the leading edge of the count signal from the I-F Subtractor clocks the sync flip-flop, I7b, the divider is released. The next 250 count inputs to I3 occur during the count interval. The count interval will last for a total of 250,000 divider inputs from the 1.0 MHz Reference Oscillator for a 0.25 second interval.

4.5.3 The Q3 (4 count) output A2I2a-13 is used as a source for the 1.0 kHz calibration signal.

4.5.4 When the M.S.D. counter A2I2b is advanced to a count of 2, the Q2 output A2I2b-4 goes hi. This hi provides a count inhibiting input to A2I2a-9. The count inhibiting action extends the count interval until after I2b is advanced to a 3 count. The extended count interval contributes to the blinking decimal point display used to indicate above range tuning.

4.6 CONTROL SIGNAL GENERATOR

4.6.1 The Control Signal Generator consists of A2I5b, A2I4, A2I5d, A2I7a and A2I5c. The wave shapes of various signals into and generated by the block are shown in figure 4-3. During the count interval, the decade Johnson Counter A2I4 will remain in a 0 count state. The hi output from I4-3 Q0 is inverted by A2I5c and provides a lo enabling input to the Count Gate A2I9d. For the normal positive frequency condition, the subtractor C9

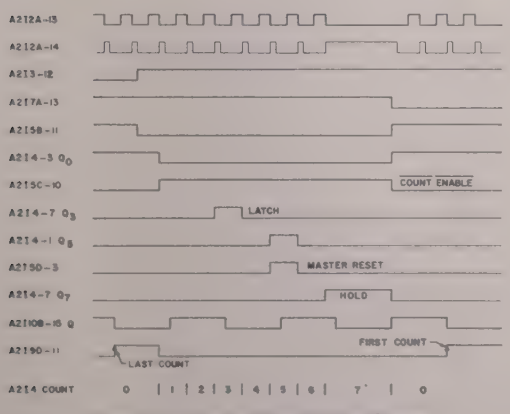

Figure 4-3. Control Signal Waveshapes

input to I5d will be lo. This means that both the Master Reset and Latch outputs from the generator are lo for the count interval. Differing inputs to I5b provide a hi count inhibiting input to I4-13. On count 256 or 0 of I3, the Q9 output I3-12 goes lo and counter I4 is enabled. For the succeeding six rises of I2a-14, counter I4 will be advanced.

4.6.2 As I4 advances for a 0 to a 1 count, the count interval is terminated. For any count other than 0 for I4, the input from I5c to I9d will be hi and hold the I9d output lo preventing inputs to the display counter. Counts 1 and 2 of I4 simply allow time for the final count input to propagate through the display counter and account for 2 of the 6 excess counts from I3. On count 3, the Q3 output I4-7 goes hi and provides a latching signal to the display counter and to the M.S.D. hold flip-flop A2I11b. Count 4 simply provides separation between the Latch and Master Reset pulses. On count 5, the Q5 output I4-1 rises. With a lo at the subtractor input to I5d, the rise of I4-1 is gated through I5d non-inverted and provides a Master Reset input to the display counter through I5d non-inverted and provides a Master Reset input to the display counter and M.S.D. counter I2b. Count 6 of I4 is used to account for the 6th excess count from I3. On count 7, the hi Q7 output from I4-6 provides a reset input to I1a-15 holding the Time Base Divider off until released by the action of the Sync block. I4 will be reset to a 0 count when the Sync block provides a hi at I4-15. This resetting hi will release the Time Base Divider and enable the Count state, initiating a new count interval.

4.7 COUNT GATE

4.7.1 The Count Gate block consists only of Nor Gate A2I9d. During the count interval, the lo input to I9d-12 permits the output to the Display and M.S.D. block to be controlled by the I-F Subtractor output I10b-13. During the count conditioning interval, the gate output I9d-11 is held lo by the hi at I9d-12.

4.8 SYNC

4.8.1 The Sync blocks consist of A2I7b and A2I6. Under conditions where the unit is not operating in a CAL mode, a hi input to I6b-5 and 6, is inverted by I6b and again by I6d to provide a constant hi to I6c-8. The output of I6c-10 to I4-15 is controlled by I7b. I7b is normally reset. When I4 goes to the Q7 hi Hold state the setting of I7b is enabled. When I7b is clocked and set by the I-F Subtractor output I10b-13, I4 is reset and the Hold signal is removed. This holding action synchronizes the start of a count interval with the leading edge of a count signal cycle.

4.8.2 With the unit in the CAL mode, the holding action would disturb the CAL signal and cause jitter in the level reading. This is prevented by the lo input to I6b for the CAL mode. The lo input to I6b results in a hi input to I6d-12, which in turn gates the I4Q7 output through I6d and I6c back to I4-15. This means a hi I4Q7 resets I4 and prevents any extended Hold pulse.

4.8.3 In the case where the unit is tuned to a frequency near zero, the sync action could cause a noticeable blinking of the display. This blinking is prevented by A2C8, and A2R9. During an extended Hold pulse, the hi output from I5c-10 will charge C8. When the voltage on C8 reaches the hi level threshold point for I7b-6, I7b will be set and the Hold will be released.

4.9 M.S.D.

4.9.1 The Most Significant digit (M.S.D.) block consist of A2I2b and A2I11b. I2b acts as the counter stage for the most significant decimal digit while I11b acts as the latch. The latch

provides a hi input to the Display when a 1 is to be displayed for the 10,000 digit. Counter I2b is advanced by the carry output of A3I1 of the Display. At the end of each count interval, the Latch signal clocks I11b. If I2b contains a count of 1, I11b will be set and a 1 will be displayed for the 10,000 digit during the suceeding count interval. Following the Latch signal, I2b will be reset for the next count interval.

4.9.2 If the tuning exceeds 19,999, the second carry output from the display counter generates a hi Q2 output from I2b-4. This hi turns on A3Q1 and four display decimal points. The decimal point signal is not latched. To ensure the decimal point is visible, the hi I2b-4 signal drives I2a-9, holding off I2a and I3 to extend the count interval. The count interval will terminate following the fourth count input to I2b which will bring the Q2 output I2b-4 lo.

4.10 CAL

4.10.1 The Cal block is provided by A2Q3. Q3 acts as a switch to prevent the Cal signal from leaving the A2 board when the unit is not being calibrated. When FUNCTION switch S1 is not in a CAL position, the hi level supply voltage is placed on the CAL line. The CAL signal hi saturates Q3, placing a short across A2R6 preventing any significant signal at the R6 wiper. When S1 is placed in the CAL position, the CAL line is pulled lo through A2R5 and Q3 is turned off. With Q3 off, the 1 kHz output from I2a-13 is coupled through A2R7 to trimmer R6. The adjustment of R6 is intended to provide a –30 dBm level calibration signal to the unit input at 1 kHz.

4.11 TRACKING GENERATOR

4.11.1 The Tracking Generator consist of A2I11a and A2Q4 and A2Q5. Flip-flop I8a of the I-F Subtractor has an output frequency two times the selected input frequency. I11a divides the I8a output signal by two to provide a signal equal to the selected input signal. The resistor network and emitter followers Q4 and Q5 convert the I11a outputs to a 0 dBm 600–ohm output impedance signal.

4.12 DISPLAY

4.12.1 The Display block consist of circuitry on board A3. A3I1 is an L.S.I. pack containing counting, latching, decoding and multiplexing functions for a four decade count.

4.12.2 Transistors A3Q3 through Q6 are driven by the digit select outputs from I1 and provide a path for cathode currents for the selected seven-segment display. The most significant digit display is only used to display a 1 for frequencies from 10,000 to 19,999. This digit is driven by A3Q2. Decimal point anodes for the multiplexed digits are driven by A3Q1 and will be turned on for counts above 19,999.

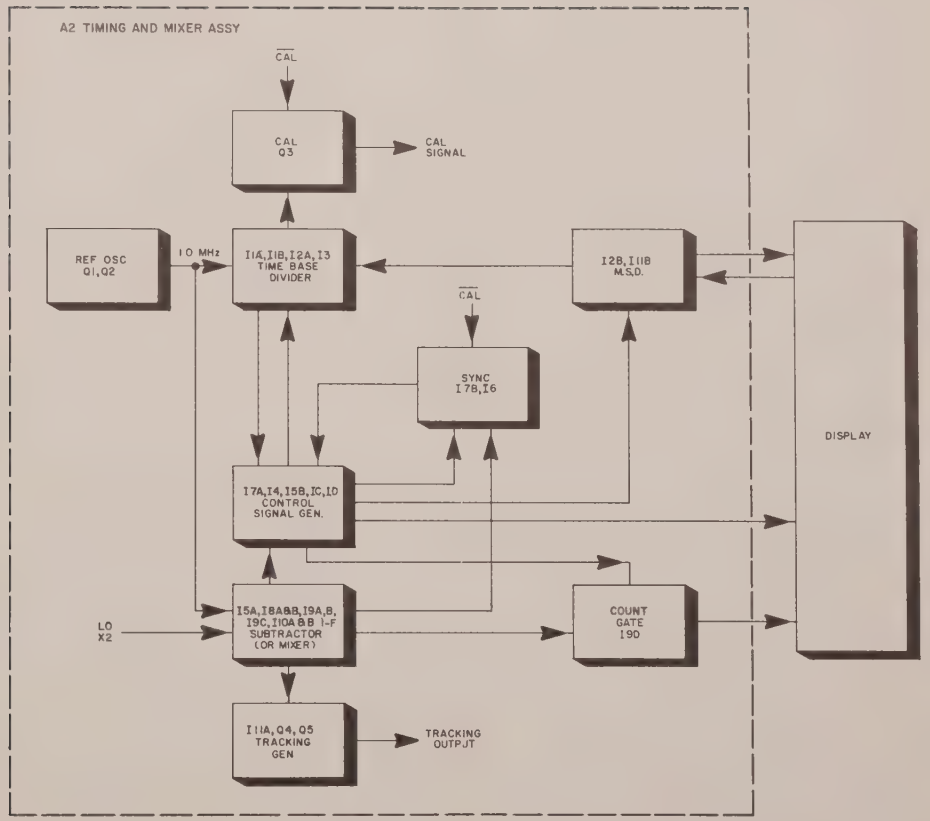

Figure 4-1. Frequency Display Block Diagram

CHAPTER 5
MAINTENANCE

5.0 INTRODUCTION

5.0.1 This instrument will give comparitively trouble free performance provided normal operating procedures are observed. In the event of any malfunction, first check the battery by turning the FUNCTION switch to the BAT. TEST position and observe the meter for an indication of 0 dBm or greater.

5.0.2 Before attempting to troubleshoot the instrument, you should study Chapters 3 and 4, Theory of Operation.

5.1 TEST EQUIPMENT

5.1.1 The test equipment in table 5-1 is necessary for checkout and alignment of the instrument.

Table 5-1. Test Equipment

Signal Generator
Digital Voltmeter (DVM)
Wideband AC Voltmeter
50-ohm Decade Attenuator
50-ohm Load
Power Supply — 35 V DC
100 ohm ±5%, 2 watt resistor
1500 ohm ±5%, ¼ watt resistor
Oscilloscope — Textronix 465 or equivalent

5.2 TROUBLE SHOOTING

5.2.1 a. Connect the equipment in the test setup as shown in figure 5-1. Set the instrument switches and controls as follows:

Switch/Control	Position
INPUT	BRG — 600Ω
FUNCTION	CAL 1 kHz
CAL LEVEL	Adjust for 0 dBm meter indication
TUNING	Adjust for 1000 Hz display
AUDIO LEVEL	Adjust for desired tone level

b. All measurements taken are with reference to chassis ground unless otherwise stated.

Note: When the instrument covers are removed, the frequency of the digital display will deviate by as much as 600 Hz depending on the proximity of ferrous or non-ferrous material at VCO coil L1. This condition is normal and does not alter measurements. The instrument should be retuned accordingly.

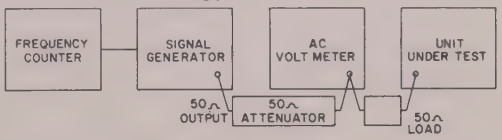

Figure 5-1. Test Setup

Table 5-2. Power System

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	Rotate FUNCTION switch to BAT. TEST position.	Meter indicates 0 DBM or more.	Battery needs recharging or is defective.
		Digital display reads 0000 or 10000.	Defective LED readout on A3 board or defective A2 board.
2	Set FUNCTION swich to CAL 1 KHz. Connect DVM to each of the following test points on assemblies A1 and A2.		
	A1E16 (CR1+)	17.0 V DC	Defective power transformer or rectifier CR1.
	A1E15 (CR1-)	0.9 V DC	
	A1I7	+12.8 - +13.3 V DC	Faulty regulator or support components on associated board.
	A1I4	+7.8 - +8.2 V DC	
	A1I5	+5.8 - +6.2 V DC	
	A1I13	+5.8 - +6.2 V DC	

Table 5-3. Receiver Assembly A1

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	Connect the equipment and set the controls as given in paragraph 5.2.1. except set FUNCTION switch to 0 DBM. Adjust the signal generator to 1 kHz at 0 dBm using an AC voltmeter as a reference level indicator.	Meter indicates 0 DBM ±1 dB.	Troubleshoot the A1 board as described in step 2.
2	Connect probe to AC voltmeter and check the following test points:	(Nominal measurements ±10%)	
	a. A1E17	250 mV DC	Defective meter or switch A1S1 sect D.

Table 5-3. Receiver Assembly A1 (cont)

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
	b. Junction A1CR3-A1CR4.	1.05 V RMS at 250 kHz.	Faulty detector stage.
	c. A1Q5 base	15 mV RMS at 250 kHz.	Defective A1Q5 stage.
	d. A1Q4 base	0.6 mV RMS at 250 kHz.	Defective A1Q4 stage.
	e. A1FL1 output	0.6 mV RMS at 250 kHz.	Defective A1FL1 stage.
	f. A1Q1 collector	3.6 mV RMS at 1 kHz and 250 kHz.	Defective A1Q1 stage.
	g. A1Q1 base	1.9 mV RMS 1 kHz and 250 kHz.	Defective A1Q1 stage.
	h. A1R17 LPF output	1 mV RMS at 1 kHz.	Defective LPF.
	j. A1R16 LPF input	1 mV RMS at 1 kHz.	Defective A1I1 stage.
	k. A1C3 Attenuator output.	4 mV RMS at 1 kHz.	Defective Input stage.
3	Connect Frequency counter and oscilloscope to A1Q8 emitter. (Note: Probe(s) may detune VCO slightly.	5 V p-p at 1.004 MHz.	Defective VCO.

Table 5-4. Timing and Mixer Assembly A2

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	Connect the equipment and set the controls as given in paragraph 5.2.1.	0 DBM ±1 dB on meter.	Troubleshoot A1 board.
		Digital display reads 1000.	Troubleshoot A2 or A3 board.
		SIGNAL LED is lit.	Troubleshoot A2 board.
2	Connect Frequency counter and oscilloscope to A2TP1.	6 V p-p at 500 kHz ±1 kHz	Reference oscillator is defective or needs alignment.
3	Connect Frequency counter and oscilloscope to SQUARE WAVE TRACKING OUTPUT jack on rear of unit.	160 mV p-p at 1 kHz.	Defective A2 board.

Table 5-5. Display Readout Assembly A3

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	Set FUNCTION switch to CAL 1 kHz and adjust TUNING for 1 kHz.	Digital display reads 1000 Hz.	Defective A3 or A2 board.
		SIGNAL LED is lit.	Defective A3CR1 or A2 board.
2	Adjust TUNING for 1010 Hz and then to 990 Hz.	SIGNAL LED blinks or is unlit.	A2 board needs alignment
		Meter reads -20 DBM ±1 dB.	A1 board needs alignment.
3	Adjust TUNING for 20000 Hz	Decimal points blink on display (Actual frequency indicated is not relevant).	Defective A2 or A3 board.
4	Adjust TUNING for 18888 Hz.	All LED segments lit.	Defective LED on A3 board or A3I1.

Table 5-6. Alarm Assembly A4

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	Set FUNCTION switch to CAL 1 kHz and adjust TUNING for 1 kHz. Set AUDIO LEVEL to mid range.	Tone output from the unit.	Defective A4, R3 or LS1.
2	Adjust AUDIO LEVEL over full range and then return to mid range.	Tone level maximum at extreme CW position. No tone extreme at CCW position.	Defective R3.
3	Adjust TUNING for 1020 kHz and then to 980 Hz.	Tone off for meter readings below -20 dBm.	Defective A4.

Table 5-7. Transistor Voltage Chart.

Connect the instrument to AC power and set controls as follows:

1. No signal input.
2. FUNCTION to CAL 1 kHz.
3. TUNING to 1000 Hz.
4. CAL LEVEL for 0 DBM indication on meter.
5. INPUT switch to BRG - 600Ω.
6. AUDIO LEVEL for desired tone level.

Readings taken with DVM and should be ±10%.
All voltages are referenced to chassis ground.

Table 5-7. Transistor Voltage Chart (cont)

ASSEMBLY	TRANSISTOR	EMITTER	BASE	COLLECTOR
A1	Q1	0.7	1.4	3.6
	Q2	0	0.7	0.5
	Q3	2.9	3.6	8.0
	Q4	2.3	2.9	8.0
	Q5	1.8	2.5	8.0
	Q6	1.3	1.9	6.5
	Q7	1.0	1.7	5.0
	Q8	3.3	3.7	8.0
	Q9	0.5	0	13.0
A2	Q1	1.5	1.9	6.0
	Q2	0	0.2	4.0
	Q3	0	0.7	0.1
	Q4	2.5	2.8	6.0
	Q5	2.5	2.8	6.0
A3	Q1	0	0	6.0
	Q2	0	0	6.0
	Q3	0	0.2	1.3
	Q4	0	0.2	1.3
	Q5	0	0.20	1.3
	Q6	0	0.20	1.3

Table 5-8. Integrated Circuit Voltages

Test Conditions are same as those given in table 5-7.
N.C. = No connection.

INTEGRATED CIRCUIT	PINS 1	2	3	4	5	6	7	8
A1I1	N.C.	4.0	4.0	0	N.C.	4.0	8.0	N.C.
A1I4	13.2 (Input)	0	8.0 (Output)	—	—	—	—	—
A1I5	13.2 (Input)	0	8.0 (Output)	—	—	—	—	—
A1I6	1.2	14.4	14.5	0	1.2	14.0	14.6	14.0
A1I7	18.8 (Input)	13.0	14.6 (Output)	—	—	—	—	—
A2I12	0.5 Signal LED on	0.26	0.02	0	0	0	N.C.	6.0
A2I13	13.2 (Input)	0	6.0 (Output)	—	—	—	—	—
A4I1	2.3 (Output)	2.3	2.3	0	0.26	0.04	4.6	6.0

5.3 ALIGNMENT

5.3.1 Except where indicated, all tests are made with the unit under test powered from the AC line.

5.3.2 All signal levels given in dBm are referenced to 600-ohms: 0 dBm=0.775 volts RMS.

5.3.3 Unless otherwise stated, input signals are applied across the input terminals of the instrument.

5.4 POWER SUPPLY

5.4.1 Disconnect the red wire from A1E13 and position it so it cannot short to the chassis. Connect a 100-ohm (2 watt) resistor from A1E13 to ground. Monitor the DC voltage at A1E13 with a digital voltmeter (DVM).

5.4.2 Set the FUNCTION switch to CHARGE and adjust A1R54 for 14.4 volts. Be sure the AC indicating LED on the front panel is illuminated.

5.4.3 Replace the 100-ohm resistor from A1E13 to ground with a 1500-ohm (½ watt) resistor. The voltage at A1E13 should drop to 13.6-13.9 volts.

5.4.4 Turn the FUNCTION switch to OFF and reconnect the red wire to A1E13.

5.4.5 Turn the FUNCTION switch to ON and check the three on-board regulators for proper DC voltage outputs.

REGULATOR	REGULATED VOLTAGE
A1I7	12.8 - 13.2 V DC
A1I4	7.8 - 8.2 V DC
A1I5	7.8 - 8.2 V DC
A2I1	5.8 - 6.2 V DC

5.5 REFERENCE OSCILLATOR ADJUSTMENT

5.5.1 Monitor the frequency at A2TP1 with a frequency counter having at least 1.0 ppm accuracy. (The frequency counter must be isolated from the test point with a scope probe or a 10 megohm resistor).

5.5.2 Allow at least five minutes warm-up time before adjustment of A2C1. Using a non-metallic tuning tool, adjust A2C1 to obtain 500,000 Hz.

5.6 LO ALIGNMENT

5.6.1 Rotate the front panel TUNING control to its extreme CCW position and set A1R35 to its (approximate) mid-range setting.

5.6.2 Connect a frequency counter input between A2E1 and ground (tracking output) to monitor the LO range.

5.6.3 Adjust L1 for 3 kHz below zero frequency on the external frequency counter. (Below zero frequency, the display reads all zeros).

5.6.4 Rotate TUNING control to maximum CW position and adjust A1R35 for 23000 on the external counter.

5.6.5 Recheck the low frequency (TUNING maximum CCW). If necessary, equalize the frequency shifts at the TUNING extremes by adjusting A1R35.

5.6.6 Observe the frequencies at the TUNING extremes. The frequency shifts must be at least 2 kHz above and below the instrument range.

5.6.7 Disconnect the frequency counter leads.

5.7 I-F ALIGNMENT

5.7.1 a. Connect the equipment as shown in figure 5-2.

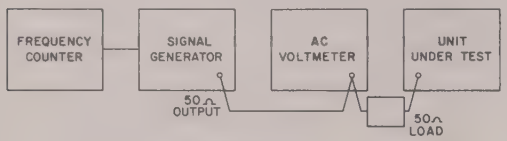

Figure 5-2.

b. Set the instrument switches and controls as follows:

Switch/Control	Position
CAL LEVEL	Fully CW
INPUT	BRG – 600Ω
FUNCTION	0 DBM

5.7.2 Set the signal generator for 1,000 Hz ±2 Hz at 0 dBm (0.775 V RMS).

5.7.3 Adjust the TUNING control for 1000 Hz reading in the display and adjust A1T2 and A1T3 for a peak meter reading. Repeat adjustment on A1T2 and A1T3 as required.

Note: Throughout the tuning process, adjust CAL LEVEL as necessary to keep the meter pointer on scale.

5.7.4 Adjust TUNING for maximum meter indication and set CAL LEVEL fully CCW. The meter indication should be less than –5 dB.

5.7.5 Set FUNCTION switch to +10 DBM and set CAL LEVEL fully CW. The meter indication should be greater than –5 DBM.

5.8 METER LINEARITY

5.8.1 a. Connect the equipment as shown in figure 5-3.

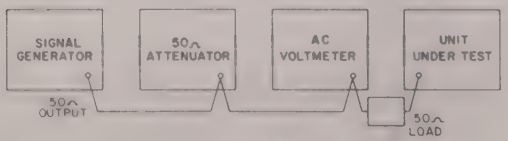

Figure 5-3.

b. Set the instrument switches and controls as follows:

Switch/Control	Position
FUNCTION	0 DBM
INPUT	BRG-600Ω

5.8.2 Set the decade attenuator to 0 dBm and set the signal generator for 1.0 kHz at 0 dBm (0.775 V RMS).

5.8.3 Adjust TUNING for maximum meter indication and adjust CAL LEVEL for 0 dB meter indication.

5.8.4 Increase decade attenuator setting by 10 dB. Meter indication should be –10 ±0.5 dB.

5.8.5 Increase decade attenuator setting by an additional 10 dB. Meter indication should be 20 ±1.0 dB.

5.8.6 Decrease decade attenuator setting by 20 dB. Meter should return to zero.

5.8.7 Increase the signal generator by 3.0 dB. Meter indication should be +3.0 ±0.3 dB.

5.8.8 Decrease the signal generator level to 0 DBM (0.775 V RMS). Place INPUT switch in the TERM–900Ω position. Meter indication should drop to the green "tick" mark.

5.9 ATTENUATOR TRACKING

5.9.1 a. Connect the equipment as shown in figure 5-4.

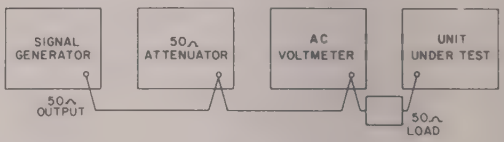

Figure 5-4.

b. Set the instrument switch and controls as follows:

Switch/Control	Position
FUNCTION	+10 DBM
INPUT	BRG – 600Ω

5.9.2 Set the decade attenuator to 0 dB and set the signal generator for 1.0 kHz at +10 dBm (2.45 V RMS).

5.9.3 Adjust TUNING for maximum meter indication and adjust CAL LEVEL for 0 dB meter indication.

5.9.4 a. Increase decade attenuator setting 10 dB.
b. Turn FUNCTION switch one position CCW.
c. Meter indication should be 0 ±0.5 dB.

5.9.5 Repeat step 5.9.4a, b and c for FUNCTION settings down to –40 DBM.

5.10 CAL OSC and SIGNAL THRESHOLD ADJUSTMENTS

Note: Because the calibration signal is a square wave, a comparison technique is used to adjust the 1000 Hz component to the required level.

5.10.1 a. Connect the equipment as shown in figure 5-5.

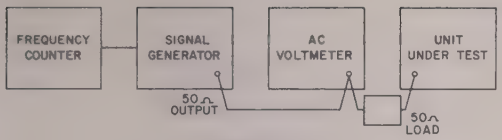

Figure 5-5.

b. Set the instrument switches and controls as follows:

Switch/Control	Position
FUNCTION	0 DBM
INPUT	BRG - 600Ω

5.10.2 Set the signal generator to exactly 1000 Hz at a 0 dBm level (0.775 V RMS).

5.10.3 Adjust TUNING for maximum meter indication and adjust CAL LEVEL for a 0 DBM meter indication. **Caution:** The CAL LEVEL control must not be disturbed until A2R6 adjustment is made.

5.10.4 Set the FUNCTION switch to CAL 1KHz and adjust A2R6 to obtain a 0 DBM meter indication.

5.10.5 Repeat steps 5.10.2 through 5.10.4 until no change in DBM reading occurs when switching between 0 DBM and CAL 1KHz.

5.10.6 With the FUNCTION switch set to 0 DBM, reduce the generator output level to -20 dBm. Adjust A2R19 to obtain a "lamp-on" signal threshold of -20 DBM.

5.11 BANDPASS RESPONSE

5.11.1 a. Connect the equipment as shown in figure 5-6.

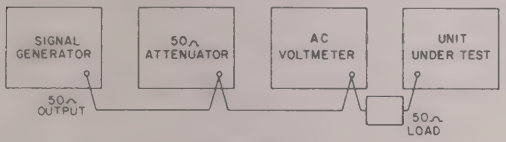

Figure 5-6.

b. Set the instrument switches and controls as follows:

Switch/Control	Position
FUNCTION	0 DBM
INPUT	BRG - 600Ω

5.11.2 Set the signal generator for 1000 Hz at 0 dBm.

5.11.3 Adjust TUNING control for maximum meter indication and adjust CAL LEVEL for 0 DBM meter indication.

5.11.4 Increase signal generator frequency until the meter indicates -3.0 and record the frequency. Decrease the signal generator below 1000 Hz and obtain the lower 3 dB frequency. Record the frequency. Compute the difference and the instrument center frequency from these two readings. Bandwidth should be 10 ±2Hz. Center frequency should be 1000 ±3 Hz.

5.11.5 For 20 dB bandwidth, increase the signal generator frequency until the meter indication drops 20 dB ("0" reading on the -20 DBM position of the FUNCTION switch). Record the frequency. Decrease the signal generator frequency below 1000 Hz until the meter reads "0" in the -20 DBM position. Record this frequency. Compute the difference. Bandwidth should be 20 ±5Hz.

5.11.6 For 60 dB bandwidth, increase the signal generator frequency until the meter indication drops to -20 on the -40DBM scale. Record the frequency. Decrease the signal generator below 1000 Hz until the meter reads -20 on the -40 DBM scale. Record this frequency. Compute the difference. Measured bandwidth should be less than 60 Hz.

5.12 FREQUENCY RESPONSE

5.12.1 a. Connect the equipment as shown in figure 5-7.

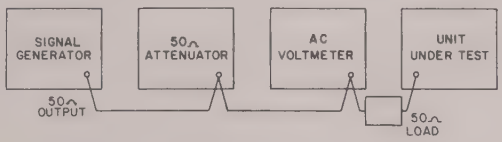

Figure 5-7.

b. Set the instrument switches and controls as follows:

Switch/Control	Position
FUNCTION	0 DBM
INPUT	BRG - 600Ω

5.12.2 Set the signal generator to 1000 Hz at a 0 DBM level (0.78 V).

5.12.3 Adjust TUNING for maximum meter indication and CAL LEVEL for 0 DBM meter indication.

5.12.4 Disconnect signal generator and connect patch cord between TRK output and INPUT jacks. Adjust CAL LEVEL for 0 DBM. Observe the meter while tuning across the band. Deviation (from zero) should be less than ±1 DBM in the 50 Hz to 19,999 Hz band. (2 dB roll-off is permissible at 20 Hz). Remove patch cord when test is completed.

CHAPTER 6
PARTS LIST

6.0 HOW TO ORDER PARTS.

6.0.1 When ordering parts, always include:

a. Name, Model and Serial Number of the instrument.
b. Assembly and reference designation.
c. Part number.
d. Description.

Order parts from:

RYCOM INSTRUMENTS INC.
9351 East 59th Street
Raytown, Missouri 64133 Telephone 816-353-2100

PARTS LIST

REF DES	DESCRIPTION	RYCOM NO.	QTY/ ASSY
	PARTS LOCATED ON FRONT PANEL, REAR PANEL OR CHASSIS		
BT1, BT2	Battery, 6 V, 1.8 AH	770 00014 00	2
CR1	Rectifier, Bridge	410 00025 00	1
E1	Binding Post, Red	812 00038 00	2
E2	Binding Post, same as E1		ref
F1	Fuse, 3AG SLO-BLOW	723 00001 00	1
J1	Jack, 3-conductor	812 00043 00	2
J2	Connector, Electrical	812 00027 00	1
J3	Jack, same as J1		ref
L1	Coil, Oscillator	701 00036 00	1
LS1	Piezoelectric Generator	743 00005 00	1
M1	Meter, 0–100 μA	740 00008 02	1
R1	Res, Var, 2000 ohms ±10%, 2W at 70°C	542 00019 00	1
R2	Res, Var, 10 k ohms ±30%, ¼ W, comp	540 00001 22	1
R3	Res, Var, 5000 ohms ±30%, ¼ W	540 00001 23	1
S1	Switch, Toggle, DPDT	722 00009 00	1
T1	Transformer, Power, 115 V AC (used in units with 115 V AC operation)	700 00038 00	1
T1	Transformer, Power, 230 V AC (used in units with 230 V AC operation)	700 00038 01	1
WA1	Cable Assembly, Ribbon W/P1 and P2	151 00021 00	1
—	Accessory Cord, Power	151 00011 00	1

PARTS LIST

REF DES	DESCRIPTION	RYCOM NO.	QTY/ ASSY
	RECEIVER ASSEMBLY A1		
A1	Circuit Card Assembly, Receiver See figure 6-1 for component location.	110 00105 00	
A1C1	Cap, 10 μF ±20%, 200 wvdc, mylar	620 00023 01	1
A1C2	Cap, 10 μF ±20%, 16 wvdc, tantalum	640 00001 01	5
A1C3	Cap, .22 μF ±20%, 12 wvdc, ceramic	600 00008 07	1
A1C4	Cap, 10 pF ±5%, 100 wvdc, mica	610 20010 21	1
A1C5	Cap, 10 μF, same as A1C2		ref
A1C6	Cap, 10 μF, same as A1C2		ref
A1C7	Cap, .012 μF ±1%, 100 wvdc, polyc'ate	620 00005 11	2
A1C8	Cap, .022 μF ±20%, 100 wvdc, polyc'ate	620 00005 14	1
A1C9	Cap, .012 μF same as A1C7		ref
A1C10	Cap, .1 μF (+80, -20%), 16 wvdc, ceramic	600 00014 00	12
A1C11	Cap, .1 μF, same as A1C10		ref
A1C12	Cap, .1 μF same as A1C10		ref
A1C13	Cap, .1 μF, same as A1C10		ref
A1C14	Cap, 10 μF, same as A1C2		ref
A1C15	Cap, .1 μF, same as A1C10		ref
A1C16	Cap, 22 μF ±20%, 16 wvdc, tantalum	640 00001 05	1
A1C17	Cap, .1 μF, same as A1C10		ref
A1C18	Cap, .1 μF, same as A1C10		ref
A1C19	Cap, .1 μF, same as A1C10		ref
A1C20	Cap, .1 μF, same as A1C10		ref
A1C21	Cap, 220 pF ±5%, 1000 wvdc, N330, ceramic	601 00001 30	1
A1C22	Cap, 33 pF ±5%, 1000 wvdc, N330, ceramic	601 00001 14	1
A1C23	Cap, 300 pF ±5%, 100 wvdc, mica	610 20300 21	1
A1C24	Cap, .01 μF ±20%, 100 wvdc, ceramic	600 00001 03	2
A1C25	Cap, 3000 pF ±5%, 500 wvdc, mica	612 23001 23	1
A1C26	Cap, 4000 pF ±5%, 500 wvdc, mica	611 24000 23	1
A1C27	Cap, .01 μF, same as A1C24		ref
A1C28	Cap, .1 μF, same as A1C10		ref
A1C29	Cap, .1 μF, same as A1C10		ref
A1C30	Cap, 100 μF (+50, -10%), 16 wvdc, elec't	630 00007 01	1
A1C31	Cap, .001 μF ±20%, 500 wvdc, ceramic	600 00009 00	1
A1C32	Cap, .1 μF (+80, -20%), 25 wvdc, ceramic	600 00006 12	1
A1C33	Cap, 10 μF, same as A1C2		ref
A1C34	Cap, 1000 μF (+50, -20%), 35 wvdc, elect'c	630 00007 06	1
A1C35	Cap, .1 μF, same as A1C10		ref
A1C36	Cap, 1320 pF ±2%, 100 wvdc, mica	611 21320 11	1
A1C37	Cap, .1 μF ±20%, 100 wvdc, ceramic	600 00013 00	1
A1CR1	Diode, zener, type 1N960B	410 00017 00	2
A1CR2	Diode, type 1N960B, same as A1CR1		ref
A1CR3	Diode, germanium, type 1N277	410 00005 00	2
A1CR4	Diode, type 1N277, same as A1CR3		ref
A1CR5	Diode, varactor, type KV1702	410 00032 00	1
A1CR6	Diode, rectifier, type CB80	410 00023 00	2
A1CR7	Diode, type CB80, same as A1CR6		ref
A1CR8	Diode, silicon, type 1N914	410 00014 00	4
A1CR9	Diode, type 1N914, same as A1CR8		ref
A1CR10	Diode, LED, Green, type 5082-4955	410 00038 01	1
A1CR11	Diode, type 1N914, same as A1CR8		ref
A1CR12	Diode, type 1N914, same as A1CR8		ref
A1CR13	Diode, STABSTR, type 5179	410 00041 00	1
A1FL1	Filter, Bandpass, 10 Hz at 250 kHz	760 00017 00	1
A1I1	IC, Dip, OP-amp, type LF356	431 00077 01	1
A1I2	IC, Dip, type 4013	430 00048 00	1
A1I3	IC, Dip, type 4016	430 00084 00	1

REF DES	DESCRIPTION	RYCOM NO.	QTY/ ASSY
	RECEIVER ASSEMBLY A1		
A1I4	IC, Voltage reg., type 78L08	431 00073 00	2
A1I5	IC, Voltage reg., type 78L08, same as A1I4		ref
A1I6	IC, Dip, Op-amp, type LM301A	431 00076 00	1
A1I7	IC, Voltage reg., type LM317T	431 00061 00	1
A1J1	Socket, IC, low profile, 8-pin	813 00013 00	1
A1L1	Coil Assembly, 5.95 mH	701 00037 00	2
A1L2	Coil Assembly, 5.95 mH, same as A1L1		ref
A1L3	Coil, rf, 150 μH	701 00015 00	2
A1L4	Coil, rf, 150 μH, same as A1L3		ref
A1L5	Coil, rf, 1 mH	701 00017 02	1
A1Q1	Transistor, silicon, NPN, type BC169B	400 00029 00	1
A1Q2	Transistor, silicon, NPN, type 2N3704	400 00013 00	3
A1Q3	Transistor, silicon, NPN, 2N3710 selected	400 00002 01	3
A1Q4	Transistor, 2N3710, same as A1Q3		ref
A1Q5	Transistor, 2N3710, same as A1Q3		ref
A1Q6	Transistor, silicon, NPN, type 2N3710	400 00002 00	2
A1Q7	Transistor, 2N3710, same as A1Q6		ref
A1Q8	Transistor, 2N3704, same as A1Q2		ref
A1Q9	Transistor, 2N3704, same as A1Q2		ref
A1R1	Res, 100 k ohms ±5%, ¼ W, carbon	500 00104 00	2
A1R2	Res, 604 ohms ±1%, ¼ W, 70°C, film	511 16040 00	3
A1R3	Res, 909 ohms ±1%, ¼ W, 70°C, film	511 19090 00	1
A1R4	Res, 100 k ohms ±1%, ¼ W, 70°C, film	511 11003 00	1
A1R5	Res, 68.1 k ohms ±1%, ¼ W, 70°C, film	511 16812 00	1
A1R6	Res, 21.5 k ohms ±1%, ¼ W, 70°C, film	511 12152 00	1
A1R7	Res, 6810 ohms ±1%, ¼ W, 70°C, film	511 16811 00	1
A1R8	Res, 2150 ohms ±1%, ¼ W, 70°C, film	511 12151 00	1
A1R9	Res, 681 ohms ±1%, ¼ W, 70°C, film	511 16810 00	1
A1R10	Res, 316 ohms ±1%, ¼ W, 70°C, film	511 13160 00	1
A1R11	Res, 300 k ohms ±5%, ¼ W, carbon	500 00304 00	2
A1R12	Res, 300 k ohms, same as A1R11		ref
A1R13	Res, 360 k ohms ±5%, ¼ W, carbon (nominal value)	500 00364 00	1
A1R14	Res, 910 k ohms ±5%, ¼ W, carbon	500 00914 00	1
A1R15	Res, 240 k ohms, ±5%, ¼ W, carbon	500 00244 00	1
A1R16	Res, 604 ohms, same as A1R2		ref
A1R17	Res, 604 ohms, same as A1R2		ref
A1R18	Res, 180 k ohms ±5%, ¼ W, carbon	500 00184 00	1
A1R19	Res, 2000 ohms ±5%, ¼ W, carbon	500 00202 00	3
A1R20	Res, 330 ohms ±5%, ¼ W, carbon	500 00331 00	2
A1R21	Res, 1000 ohms, ±5%, ¼ W, carbon	500 00102 00	6
A1R22	Res, 3600 ohms ±5%, ¼ W, carbon	500 00362 00	1
A1R23	Res, 10 k ohms ±5%, ¼ W, carbon	500 00103 00	3
A1R24	Res, 8200 ohms ±5%, ¼ W, carbon	500 00822 00	2
A1R25	Res, 2000 ohms, same as A1R19		ref
A1R26	Res, 51 k ohms ±5%, ¼ W, carbon	500 00513 00	1
A1R27	Res, 1000 ohms, same as A1R21		ref
A1R28	Res, var, 500 ohms ±20% cermet	542 00020 00	1
A1R29	Res, 330 ohms, same as A1R20		ref
A1R30	Res, 10 k ohms, same as A1R23		ref
A1R31	Res, 4700 ohms ±5%, ¼ W, carbon	500 00472 00	1
A1R32	Res, 8200 ohms, same as A1R24		ref
A1R33	Res, 27 k ohms ±5%, ¼ W, carbon	500 00273 00	1
A1R34	Res, 1500 ohms ±5%, ¼ W, carbon	500 00152 00	1
A1R35	Res, var, 1000 ohms ±20%, cermet	542 00021 05	2
A1R36	Res, 1800 ohms ±5%, ¼ W, carbon	500 00182 00	2
A1R37	Res, 100 k ohms, same as A1R1		ref

PARTS LIST

REF DES	DESCRIPTION	RYCOM NO.	QTY/ ASSY
	RECEIVER ASSEMBLY A1		
A1R38	Res, 3000 ohms ±5%, ¼ W, carbon	500 00302 00	2
A1R39	Res, 1000 ohms, same as A1R21		ref
A1R40	Res, 1000 ohms, same as A1R21		ref
A1R41	Res, 10 k ohms, same as A1R23		ref
A1R42	Res, 1000 ohms, same as A1R21		ref
A1R43	Res, 3000 ohms, same as A1R38		ref
A1R44	Res, 680 ohms ±5%, ¼ W, carbon	500 00681 00	1
A1R45	NOT USED		
A1R46	Res, 2000 ohms, same as A1R19		ref
A1R47	Res, 1800 ohms, same as A1R36		ref
A1R48	Res, .5 ohms ±3%, .4 W, wire wound	560 00002 00	1
A1R49	Res, 3.9 ohms ±5%, ¼ W, carbon	500 00039 00	1
A1R50	Res, 237 ohms ±1%, ¼ W, 70°C, film	511 12370 00	1
A1R51	Res, 33 k ohms ±5%, ¼ W, carbon	500 00333 00	1
A1R52	Res, 1000 ohms, same as A1R21		ref
A1R53	Res, 2200 ohms ±5%, ¼ W, carbon	500 00222 00	1
A1R54	Res, var, 1000 ohms, same as A1R35		ref
A1R55	Res, 3.0 ohms ±5%, 1 W, carbon	504 00030 00	1
A1R56	Res, 4.7 ohms ±5%, 1 W, carbon	504 00047 00	1
A1R57	Res, 143 k ohms ±1%, ¼ W, 70°C film	511 11433 00	1
A1R58	Res, 6200 ohms ±5%, ¼ W, carbon	500 00622 00	1
A1R59	Res, 4300 ohms ±5%, ¼ W, carbon	500 00432 00	1
A1S1	Switch, rotary	720 00047 00	1
A1T1	Transformer, input	700 00039 00	1
A1T2	Transformer, I-F	700 00003 00	2
A1T3	Transformer, I-F, same as A1T2		ref

REF DES	DESCRIPTION	RYCOM NO.	QTY/ ASSY
	TIMING AND MIXER ASSEMBLY A2		
A2	Circuit Card Assembly, Timing and Mixer See figure 6-2 for component location.	110 00106 00	
A2C1	Cap, var, 5.5-18 pF, 200 wvdc, ceramic	660 00002 00	1
A2C2	Cap, .001 μF ±20%, 500 wvdc, ceramic	600 00009 00	2
A2C3	Cap, 22 pF ±5%, 100 wvdc, mica	610 20022 21	1
A2C4	Cap, 500 pF ±5%, 500 wvdc, mica	610 20500 23	2
A2C5	Cap, 500 pF, same as A2C4		ref
A2C6	Cap, .001 μF, same as A2C2		ref
A2C7	Cap, .1 μF (+80, -20%), 16 wvdc, ceramic	600 00014 00	5
A2C8	Cap, .1 μF, same as A2C7		ref
A2C9	Cap, 1 μF ±20%, 35 wvdc, tantalum	640 00001 03	1
A2C10	Cap, 100 μF (+50, -10%), 16 wvdc, elect'c	630 00007 01	1
A2C11	Cap, .1 μF ±20%, 100 wvdc, ceramic	600 00013 00	1
A2C12	Cap, .1 μF, same as A2C7		ref
A2C13	Cap, 10 μF ±20%, 10 wvdc, tantalum	640 00001 00	3
A2C14	Cap, .1 μF, same as A2C7		ref
A2C15	Cap, 10 μF, same as A2C13		ref
A2C16	Cap, .1 μF, same as A2C7		ref
A2C17	Cap, 10 μF, same as A2C13		ref
A2C18	Cap, .01 μF ±20%, 100 wvdc, ceramic	600 00001 03	1
A2CR1	Diode, germanium, type 1N277	410 00005 00	1
A2CR2	Diode, silicon, type 1N914	410 00014 00	1
A2I1	IC, Dip, type 4518	430 00009 00	2
A2I2	IC, type 4518, same as A2I1		ref
A2I3	IC, Dip, type 4040	430 00059 00	1
A2I4	IC, Dip, type 4017	430 00050 00	1
A2I5	IC, Dip, type 4030	430 00052 00	1
A2I6	IC, Dip, type 4011	430 00046 00	1
A2I7	IC, Dip, type 4013	430 00048 00	4
A2I8	IC, type 4013, same as A2I7		ref
A2I9	IC, Dip, type 4001	430 00058 00	1
A2I10	IC, type 4013, same as A2I7		ref
A2I11	IC, type 4013, same as A2I7		ref
A2I12	IC, Dual Comparator, type LM393	431 00066 01	1
A2I13	IC, Voltage reg., type 7806	431 00075 00	1
A2J1	Socket, IC, low profile, 8-pin	813 00013 00	1
A2J2	Socket, IC, low profile, 14-pin	813 00013 01	1
A2L1	Coil, rf, 47 uH	701 00032 00	1
A2L2	Coil, rf, 80 μH	701 00015 02	1
A2Q1	Transistor, silicon, NPN, 2N3710 selected	400 00002 01	1
A2Q2	Transistor, silicon, NPN, type 2N3704	400 00013 00	4
A2Q3	Transistor, type 2N3704, same as A2Q2		ref
A2Q4	Transistor, type 2N3704, same as A2Q2		ref
A2Q5	Transistor, type 2N3704, same as A2Q2		ref
A2R1	Res, 470 k ohms ±5%, ¼ W, carbon	500 00474 00	1
A2R2	Res, 1000 ohms ±5%, ¼ W, carbon	500 00102 00	3
A2R3	Res, 510 ohms ±5%, ¼ W, carbon	500 00511 00	1
A2R4	Res, 2000 ohms ±5%, ¼ W, carbon	500 00202 00	1
A2R5	Res, 10 k ohms ±5%, ¼ W, carbon	500 00103 00	1
A2R6	Res, var, 500 ohms ±20%, cermet	542 00021 00	2
A2R7	Res, 20 k ohms ±5%, ¼ W, carbon	500 00203 00	2
A2R8	NOT USED		
A2R9	Res, 1 Meg ohm ±5%, ¼ W, carbon	500 00105 00	2

PARTS LIST

REF DES	DESCRIPTION	RYCOM NO.	QTY/ ASSY
	TIMING AND MIXER ASSEMBLY A2		
A2R10	Res, 20 k ohms, same as A2R7		ref
A2R11	Res, 200 k ohms ±5%, ¼ W, carbon	500 00204 00	1
A2R12	Res, 1000 ohms, same as A2R2		ref
A2R13	Res, 1000 ohms, same as A2R2		ref
A2R14	Res, 100 ohms ±5%, ¼ W, carbon	500 00101 00	2
A2R15	Res, 1820 ohms ±1%, ¼ W, 70°C, film	511 11821 00	2
A2R16	Res, 100 ohms, same as A2R14		ref
A2R17	Res, 1820 ohms, same as A2R15		ref
A2R18	Res, 732 ohms ±1%, ¼ W, 70°C, film	511 17320 00	1
A2R19	Res, var, 500 ohms, same as A2R6		ref
A2R20	Res, 51 k ohms ±5%, ¼ W, carbon	500 00513 00	1
A2R21	Res, 1 Meg ohm, same as A2R9		ref
A2R22	Res, 330 ohms ±5%, ½ W, carbon	502 00331 00	1
A2Y1	Crystal, Quartz, 1000.000 kHz	765 00002 00	1

PARTS LIST

REF DES	DESCRIPTION	RYCOM NO.	QTY/ ASSY
	READOUT ASSEMBLY A3		
A3	Circuit Card Assembly, Readout See figure 6-3 for component location.	110 00107 00	
A3C1	Cap, 22 μF (+50, –10%), 16 wvdc, elect'c	630 00001 01	1
A3CR1	Diode, LED, Red, type 5082-4655	410 00037 01	1
A3I1	IC, Dip, type MM74C926	430 00083 01	1
A3I2	IC, LED Display, type HDSP-4033	430 00085 01	5
A3I3	IC, type 4033, same as A3I2		ref
A3I4	IC, type 4033, same as A3I2		ref
A3I5	IC, type 4033, same as A3I2		ref
A3I6	IC, type 4033, same as A3I2		ref
A3Q1	Transistor, silicon, NPN, 2N3704	400 00013 00	6
A3Q2	Transistor, type 2N3704, same as A3Q1		ref
A3Q3	Transistor, type 2N3704, same as A3Q1		ref
A3Q4	Transistor, type 2N3704, same as A3Q1		ref
A3Q5	Transistor, type 2N3704, same as A3Q1		ref
A3Q6	Transistor, type 2N3704, same as A3Q1		ref
A3R1	Res, 270 ohms ±5%, ¼ W, carbon	500 00271 00	2
A3R2	Res, 270 ohms, same as A3R1		ref
A3R3	Res, 75 ohms ±5%, ¼ W, carbon	500 00750 00	7
A3R4	Res, 75 ohms, same as A3R3		ref
A3R5	Res, 75 ohms, same as A3R3		ref
A3R6	Res, 75 ohms, same as A3R3		ref
A3R7	Res, 75 ohms, same as A3R3		ref
A3R8	Res, 75 ohms, same as A3R3		ref
A3R9	Res, 75 ohms, same as A3R3		ref
A3R10	Res, 43 ohms ±5%, ¼ W, carbon	500 00430 00	1
A3WA1	Cable Assy, ribbon W/P1, P2	151 00020 00	1

REF DES	DESCRIPTION	RYCOM NO.	QTY/ ASSY
	ALARM ASSEMBLY A4		
A4	Circuit Card Assembly, Alarm See figure 6-4 for component location	110 00104 01	
A4C1	Cap, .018 μF ±5%, wvdc, p'ycarbonate	620 00007 13	1
A4I1	IC, DIP, dual op-amp, type LM358N	431 00054 01	1
A4R1	Res, 62 k ohms ±5%, ¼ W, carbon	500 00623 00	1
A4R2	Res, 430 ohms ±5%, ¼ W, carbon	500 00431 00	1
A4R3	Res, 100 k ohms ±5%, ¼ W, carbon	500 00104 00	3
A4R4	Res, 100 k ohms, same as A4R3		ref
A4R5	Res, 100 k ohms, same as A4R3		ref
A4R6	Res, 4.7 Meg ohms ±5%, ¼ W, carbon	500 00475 00	1

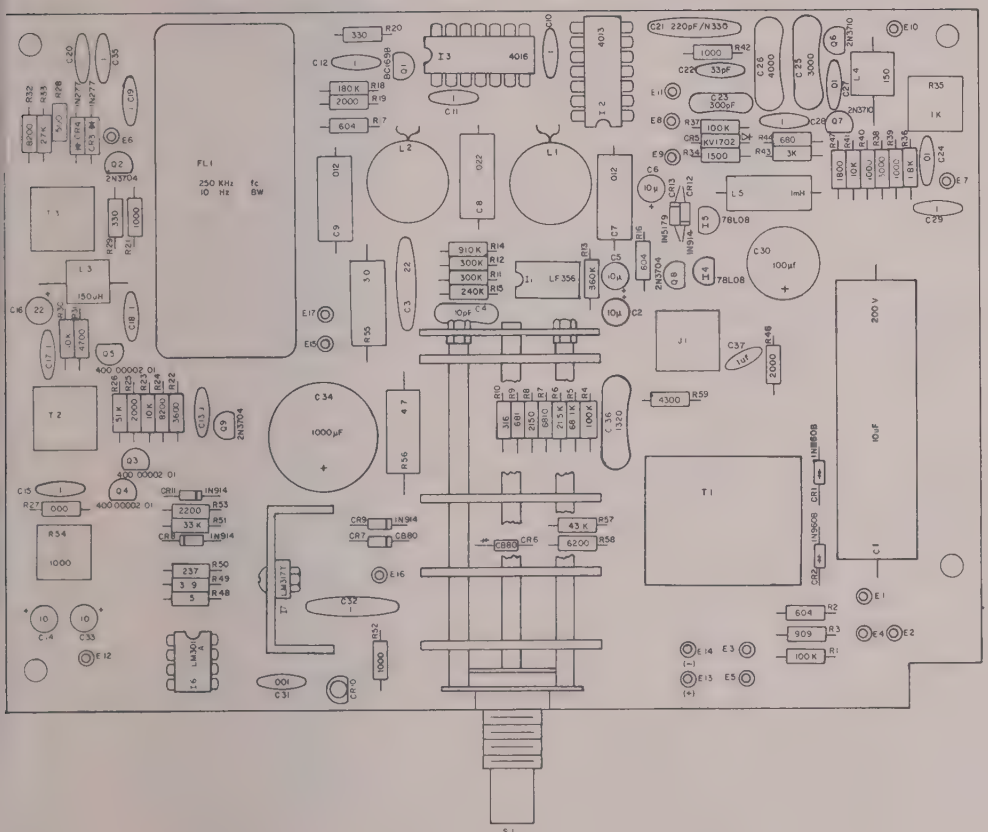

Figure 6-1. Receiver Assembly A1

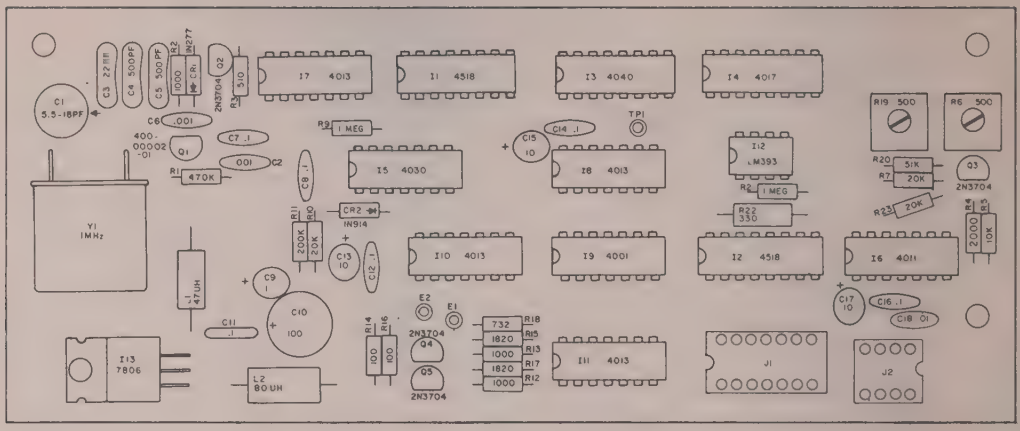

Figure 6-2. Timing and Mixer Assembly A2

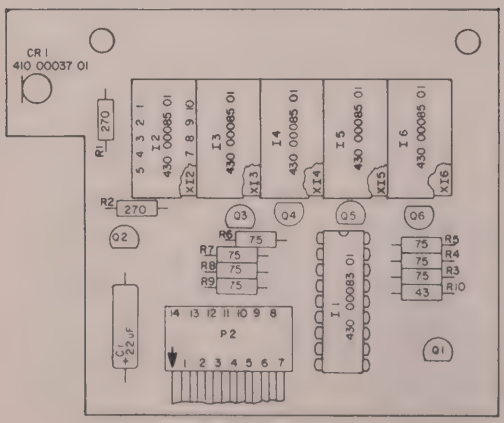

Figure 6-3. Display Readout Assembly A3

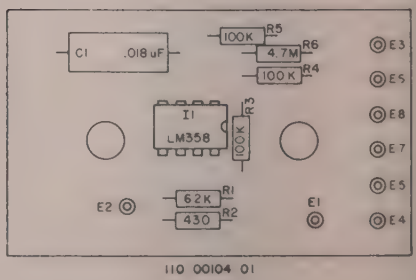

Figure 6-4. Alarm Assembly A4

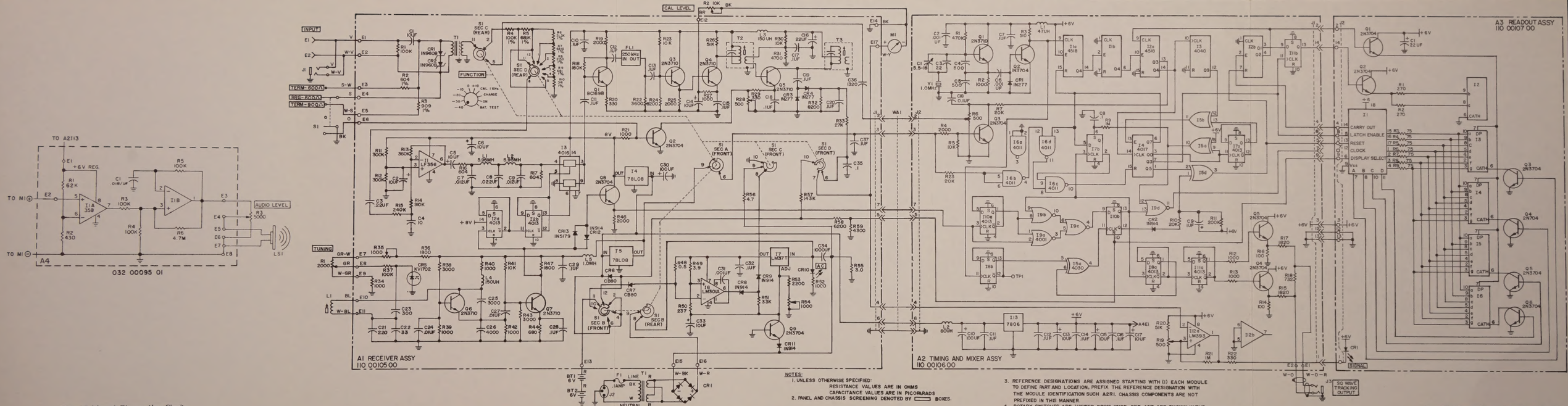

Figure 6-5. Schematic Diagram, Alarm Circuit

Figure 6-6. Schematic Diagram, R-60 Selective Levelmete

81367